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(71) Applicant 000005201
Fuji Photo Film Kabushiki Kaisha [Japanese Company or Corporation]
210-banchi, Nakanuma, Minami Ashigara-shi, Kanagawa-ken

(72) Inventor
Kazuhiro OKI
C/o Fuji Photo Film Kabushiki Kaisha
210-banchi, Nakanuma, Minami Ashigara-shi, Kanagawa-ken

(74) Agent 100083116
Kenzo MATSUURA, Patent Agent

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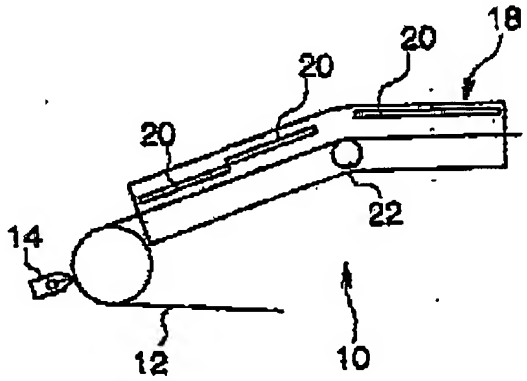
[Note: All names, addresses, company names, and brand names are translated in the most common manner. Japanese language does not have singular or plural words unless otherwise specified with numeral prefix or general form of plurality suffix. Translator's note]

(54) [TITLE OF THE INVENTION]
DRYING METHOD OF COATING FILM, AND DEVICE OF THE SAME
[Tofumaku no kanso hoho oyobi sochi]

(57) [ABSTRACT]
[OBJECT]
It controls uneven drying as well as allows drying with good efficiency when drying a coating film surface that is formed by coating various liquid-form compositions on a band-form flexible support body in continuous travel motion.

[MEANS OF SETTLEMENT]
A dryer (18) that condensates and collects a solvent within a coating solution was placed at a coating surface side of a traveling position in a manner immediately after the coating of various liquid-form compositions through means of coating (16) on a band-form flexible support body (1) in a continuous travel motion. In addition, said dryer (18) is constructed in such manner that while placing a condensation plate(s) that is a plate-form member in an almost parallel manner to the band-form flexible support body (12) with prescribed distance, distance between said condensation plate and band-form flexible support body (12) is made to vary in the traveling direction of the band-form flexible support body (12).



[CLAIMS]
[CLAIM ITEM 1]
According to a drying method of a coating film that coats a coating solution on a traveling band-form flexible support body through means of coating and has a placement of a dryer that condensates and collects a solvent within a coating solution at the traveling position in a manner immediately after the coating, the drying method of a coating film is characterized by the fact that said dryer has a placement of a condensation plate(s) that is a plate-form member in an almost parallel manner to said band-form flexible support body at prescribed distance, and at the same time, distance between said condensation plate and the band-form flexible support body is made to vary in the traveling direction of the band-form flexible support body.

[CLAIM ITEM 2]
The drying method of a coating film in accordance with the claim item 1, wherein distance between said condensation plate and band-form flexible support body is made to vary in the traveling direction of the band-form flexible support body in a stage-like manner.

[CLAIM ITEM 3]
The drying method of a coating film in accordance with the claim item 1, wherein said condensation plate is made to tilt at the prescribed angle in the traveling direction of said band-form flexible support body to vary the distance between said condensation plate and the band-form flexible support body in a tapered manner in the traveling direction of the band-form flexible support body.

[CLAIM ITEM 4]
The drying method of a coating film in accordance with the claim items 1,2, or 3, wherein said dryer has a placement of plural numbers of condensation plates in the traveling direction of the band-form flexible support body, and at the same time, has a placement of diaphragm [dashboard] either away from the condensation plates or between adjacent condensation plates.

[CLAIM ITEM 5]
The drying method of a coating film in accordance with claim items 1,2,3, or 4, wherein said coating solution includes at the least 3 percent by mass of organic solvent.

[CLAIM ITEM 6]
The drying method of a coating film in accordance with any claim items of 1 ~ 5, wherein the distance of said means of coating and said dryer is at the most 5 m.

[CLAIM ITEM 7]
The drying method of a coating film in accordance with any claim items of 1 ~ 6, wherein, the distance of said means of coating and said dryer is at most 0.7 m.

[CLAIM ITEM 8]
The drying method of a coating film in accordance with any claim items of 1 ~ 7, wherein traveling speed of said band-form flexible support body is at such speed so the band-form flexible support body would reach said dryer within 30 seconds after coating by said means of coating.

[CLAIM ITEM 9]
The drying method of a coating film in accordance with any claim items of 1 ~ 8, wherein traveling speed of said band-form flexible support body is at such speed so the band-form flexible support body would reach said dryer within 20 seconds after coating by said means of coating.

[CLAIM ITEM 10]
The drying method of a coating film in accordance with any claim items of 1 ~ 9, wherein thickness of said coating film is 0.001 ~ 0.08 mm.

[CLAIM ITEM 11]
The drying method of a coating film in accordance with any claim items of 1 ~ 10, wherein traveling speed of said band-form flexible support body is 1 ~ 100 m/minute.

[CLAIM ITEM 12]
The drying method of a coating film in accordance with any claim items of 1 ~ 12 [note: the original document states claim items of 1 ~ 12, translator's note], wherein traveling speed of said band-form flexible support body is 5 ~ 80 m/minute.

[CLAIM ITEM 13]
The drying method of a coating film in accordance with any claim items of 1 ~ 12, wherein a means of cooling is arranged on said dryer.

[CLAIM ITEM 14]
The drying method of a coating film in accordance with any claim items 1 ~ 13, wherein a means of heating is arranged at the side that is opposite to said dryer in such manner of scissoring said band-form flexible support body.

[CLAIM ITEM 15]
The drying method of a coating film in accordance with claim item 14, wherein it uses a heat roll for said means of heating.

[CLAIM ITEM 16]
The drying method of a coating film in accordance with claim item 14, wherein it uses either a infrared heater or means of heating with microwave as said means of heating.

[CLAIM ITEM 17]
The drying method of a coating film in accordance with any claim items of 1 ~ 16, wherein distance of a surface of said coating film and a surface of said dryer is 0.01 ~ 200 mm.

[CLAIM ITEM 18]
The drying method of a coating film in accordance with any claim items of 1~ 17, wherein distance of a surface of said coating film and a surface of said dryer is 0.01 ~ 100 mm.

[CLAIM ITEM 19]
The drying method of a coating film in accordance with any claim items of 13 ~ 18, wherein it is designed to vary setting temperature of said means of heating in the traveling direction of the band-form flexible support body.

[CLAIM ITEM 20]
The drying method of a coating film in accordance with any claim items of 13~ 19, wherein it is designed to vary setting temperature of said means of cooling of said dryer in the traveling direction of the band-form flexible support body.

[CLAIM ITEM 21]
The drying method of a coating film in accordance with claim item 19, wherein it is designed to vary setting temperature of said means of heating in a stage-like manner.

[CLAIM ITEM 22]
The drying method of a coating film in accordance with claim item 19, wherein it is designed to vary setting temperature of said means of heating in a gradual manner not in a stage-like manner.

[CLAIM ITEM 23]
The drying method of a coating film in accordance with claim item 20, wherein it is designed to vary setting temperature of means of cooling have said dryer in a stage-like manner.

[CLAIM ITEM 24]
The drying method of a coating film in accordance with claim item 20, wherein it is designed to vary setting temperature of means of cooling of said dryer in a gradual manner not in a stage-like manner.

[CLAIM ITEM 25]
According to a device that dries coating film comprising a means of coating that coats coating solution on a traveling band-form flexible support body and a dryer that is placed at its bottom stage to condensate and collect a solvent in the coating solution that is coated, the device that dries a coating film is characterized by the fact that said dryer has a condensation plate that is of a plate-form member that is placed in an almost parallel manner to said band-form flexible support body with prescribed distance, and distance of said condensation plate and band-form flexible support body is variable in the traveling direction of the band-form flexible support body.

[CLAIM ITEM 26]
The device that dries coating film in accordance with claim item 25, wherein means of heating is arranged at the side opposite to said dryer in a manner of scissoring said band-form flexible support body, and it is designed so the setting temperature of said means of heating can be varied in the traveling direction of the band-form flexible support body.

[CLAIM ITEM 27]
The device that dries coating film in accordance with claim item 25 or 26, wherein a means of cooling is arranged on said dryer, and it is designed so the setting temperature of said means of cooling can be varied in the traveling direction of the band-form flexible support body.

[DETAILED EXPLANATION OF THE INVENTION]
[0001]
[TECHNICAL FIELDS OF THIS INVENTION]
This invention relates to a drying method of a coating film and a device of the same; and in particular, it relates to the drying method that dries long and wide coating film surface that is formed through coating various liquid-form compositions on a continuously traveling band-form flexible support body, and the device of the same.

[0002]
This technology may be utilized for undercoating of solvent on film sheets with optical functionality such as optical compensation sheets and the like and films for photosensitive materials in addition to manufacturing of photosensitive materials for thermal development, functional films including particles with micro-structure such as nano-level particles and the like, photographic films, photographic papers, magnetic recording tapes, adhesive tapes, pressure-sensitive recording papers, offset printing materials, or batteries and the like.

[0003]
[PRIOR ART]
Regarding a drying method and device that dries long and wide coating film surface that is formed through coating of various liquid-form compositions on a continuously traveling band-form flexible support body, a coating method that is designed to dry by supporting a non-coated surface side with a roll and blowing wind [air] from an air nozzle on the coated-surface side as well as an air-floating drying method of a non-contact type that blows wind [air] from an air nozzle onto both coated surface as well as a non-coated surface to dry in a state that a support body is suspended, in other words, in a state that support body does not come in contact with a roll and the like are cited in the "Coating and Drying Defects" (Wiley-Interscience, John Wiley &: Sons, Inc.) authored by E.B.Gutoff and E.D. Cohen. According to this non-contact type drying method, a drying method that uses a string-coiled type dryer that is disclosed in the post-examined Japanese patent publication Sho 48[1973]-42903 may be mentioned as a method that is capable of utilizing a space with good efficiency in addition to drying with good efficiency.

[0004]
Regarding these ordinary methods that is designed to dry by blowing wind [air] (these will be hereafter referred to as circulation drying method), drying is conducted by blowing wind [air] of which humidity is adjusted onto a coated surface to evaporate the solvent that is included in the coated surface. Although these ordinary drying methods are excellent in drying efficiency, because it applies wind to the coated surface either directly or through a porous plate or an evener plate and the like, thickness of the coating layer becomes non-uniform causing unevenness due to disturbance that occurs on the coated surface caused by said wind [air], or evaporation speed of the solvent on the coated surface may become non-uniform due to convection current to consequently cause a so-called orange peel (make reference to "Coating Engineering" by Yuji OZAKI, pp.293~ 294, Asakura Books, 1971) presenting a problem of not possible attainment of uniform coating layer.

[0005]
In particular, occurrence of such unevenness is prominent when organic solvents are included in the coating solution. The reason for this is that during initial period of drying shows a state that includes sufficient level of organic solvent in the coating film, and when distribution by evaporation of the organic solvent occurs in this stage, distribution of temperature as well as distribution of surface tension occur on the coating film surface to result in occurrence of flow motion such as so-called Marangoni convection and the like within such coating film surface. Occurrence of such unevenness invites critical coating defects.

[0006]
When liquid crystal is included within a coating film, problems of not only above-explained uneven coating, but also, slippage on the orientation of liquid crystal on the coating film surface caused by blown wind [air] have been also pointed out.

[0007]
As a method that solves these problem points, a structure that arranges a dryer for drying immediately after coating is disclosed in the Japanese patent application laid-open Tokkai 2001-170547 publication. According to this, it discloses a method that controls occurrence of unevenness in such ways that a drier for drying is divided, and while blowing wind [air] to this divided portion from one side end of the support body in a width-wise direction to the other side end. According to the Japanese patent application of Kokai Hei 9 [1995]-73016 publication, a method that installs a metal mesh in the place of dividing a dryer for drying is disclosed based on the same purpose.

[0008]
In addition, according to the Japanese patent laid-open Tokkai 2001-170547 publication, it discloses a method that increases viscosity of a coating solution either through increase of density of the coating solution or addition of a tackifier to the coating solution to control flow motion by wind [air] for drying on the coating film surface immediately after coating, or a method that prevents from occurrence of unevenness through a leveling effect even when flow motion may occur due to the wind [air] for drying on the coating film surface immediately after coating.

[0009]
However, according to the methods disclosed in the publications of the Japanese patent laid-open Tokkai 2001-170547 or Kokai [laid-open] Hei 9[1995]-73016, although they may display an effect in controlling on in-flow of non-uniform wind from outside of the dryer for drying, when an attempt is made to control wind [air] velocity so not to disturb the coating film surface, it is necessary to significantly lower this wind [air] velocity. As a result, drying speed declines significantly, and it is necessary to lengthen the length of the dryer for drying to countermeasure against this. And therefore, coating efficiency worsens. Furthermore, it is difficult to totally eliminate the affect of wind even after such attempts.

[0010]
In addition, according to the method that tackifies coating solution or uses solution with high boiling point, as disclosed in the Japanese patent laid-open Tokkai 2001-170547 publication, it causes non-aptitude for a high speed coating or increase in drying time to present problems of extremely worsened production efficiency.

[0011]
As explained above, according to the circulation drying method, or in particular, circulation drying method when involving organic solvents in the coating solution, as it invites unevenness on drying of coating surface at initial period of drying, methods designed to dry by not blowing wind [air] are disclosed in the GB1401041, US5168639, or US 5694701 and the like.

[0012]
That is to say, a method that dries after evaporation and collection of solvent in a coating solution without blowing wind [air] is disclosed in the GB1401041. This method refers to the method that carries out drying through arrangement of an inlet and an outlet of a support body at top part of a casing, and promotes evaporation of solvent from the coating surface through heating a non-coating surface within a casing to condensate said solvent by a method that forms dewdrops on the condensation plate that is installed at the coating surface side and collects solvent.

[0013]
In addition, US5168639 discloses a method that collects solvent at top part of support body that is made to travel in a horizontal manner through use of a drum. Furthermore, according to the US5694701, an improved method of lay out [structure] of the US5168639 is disclosed.

[0014]
[SUBJECTS SOLVED BY THIS INVENTION]
However, according to the GB1401041, as inlet and outlet of the support body is limited to the top part of the casing, it places significant restrictions on the lay out of the device; and it is difficult to combine this in an existing coating process. In addition, according to the example that is illustrated in the Fig. 5, as it is necessary to allocate a greater than set distance before entering a collection dryer after coating or to reverse the base prior to entering the collection dryer, it is difficult to control unevenness that occurs immediately after coating with a level of good efficiency.

[0015]
According to the US5168639, it is difficult to control the drying speed uniformly over an entire region within a casing because distance from the coating surface to condensation and solvent collection varies by the coating direction; and in addition, because distance of coating surface and condensation/cooling drum at nearby inlet and outlet of the casing become unnecessarily far apart to result in another type of coating unevenness caused by occurrence of spontaneous convection.

[0016]
According to the improved method of lay out [structure] that is disclosed in the US5168639, it is difficult to form a structure where distance from the coating device to condensation/ collection of the solvent can be made closer, and it has been regarded insufficient as a countermeasure against coating unevenness.

[0017]
In addition, according to above-explained conventional solvent condensation and collection method, it is designed to attain uniform evaporation and collection within a device by setting the installation position of the condenser or heating device and the like in a condensation/collection device as well as setting temperature and the like. And therefore, although it is convenient to set entire region within a device at identical drying speed, it is not possible to carry out drying by selecting the optimum conditions at each stages including initial period, middle period, and last period of the drying. That is to say, it is difficult to control to gain optimum conditions for purpose of controlling coating unevenness or to control to gain fine dry film properties, and furthermore, it has been regarded as difficult to provide an efficient drying over the entire processes.

[0018]
For example, it is easily affected by precision on the distance that is set although it is necessary to reduce the distance of condensation plane of device and coating film in order to increase drying speed. In addition, when distance precision is improved, manufacturing cost of such device generally increases dramatically, and is not desirable.

[0019]
In addition, when it is desired to accomplish a uniform drying quickly during the initial period of drying, because distance of condensation plane of the device and coating film is designed to be small over entire length of condensation and collection zone in the case of conventional method, it presents a problem that it is necessary to lengthen the entire length of condensation and collection zone in this case.

[0020]
On the one hand, when drying speed during initial time of drying is to be held slow, it is necessary to reduce drying efficiency of the entire condensation and collection zone. In this case, it presents a problem that it is necessary to lengthen entire length of condensation and collection zone.

[0021]
This invention was done based on such circumstance; and according to a long and wide coating film surface that is formed by coating various liquid-form compositions on a continuously traveling band-form flexible support body, its purpose is to offer a drying method of a coating film that can control drying unevenness that occurs immediately after coating and provides drying with good efficiency, and a device of the same.

[0022]
[MEASURES USED TO SOLVE THE SUBJECTS]
According to a drying method of a coating film of which traveling band-form flexible support body is coated with a coating solution through means of coating and has a placement of a dryer that condensates and collects solvent within a coating solution at the traveling position in a manner immediately after said coating, this invention attains said purpose through such characteristics as said dryer is equipped with a condensation plate that is formed of a plate-form member in an almost parallel manner to said band-form flexible support body with prescribed distance and at the same time, distance of said condensation plate and band-form flexible support body is made to vary in the traveling direction of the band-form flexible support body.

[0023]
According to this invention, in the case of method that dries long and wide coating film surface that is formed through coating of various liquid-form compositions on a continuously traveling band-form flexible support body, it is possible to control drying unevenness that tends to occur immediately after coating and is also possible to conduct said drying with good efficiency through arrangement of a dryer that condensates and collects solvent within a coating solution immediately after means of coating, and in addition, through placement of a condensation plate that is of a plate-form member to that dryer in an almost parallel manner to the band-form flexible support body with prescribed distance and through varying the distance of condensation plate and band-form flexible support body in the traveling direction of said band-form flexible support body.

[0024]
In particular, the effects remain significantly large in such case when an organic solvent[s] is included in the coating solution, or when all the solvents in the coating solution are composed of organic solvents.

[0025]
Furthermore, this invention is characterized by the fact that said coating solution includes at the least 3 percent by mass organic solvent. It is possible to control drying unevenness that occurs immediately after coating and is possible to dry with a good level of efficiency through use of this invention even in the case explained above.

[0026]
In addition, regarding organic solvents, they refer organic compounds showing properties of dissolving substances of which examples include followings: aromatic hydrocarbons such as toluene, xylene, or styrene and the like; chlorinated aromatic hydrocarbons such as chlorbenzene, or ortho-dichlorbenzene and the like; chlorinated aliphatic hydrocarbons including methane derivatives such as monochlormethane and the like, or ethane derivatives such as monochlorethane and the like; alcohols such as methanol, isopropyl alcohol, or isobutyl alcohol and the like; esters such as methyl acetate, or ethyl acetate and the like; ethers such as ethyl ether, or 1,4-dioxane and the like; ketones such as acetone, or methyl ethyl ketone and the like; glycol ethers such as ethylene glycol monomethyl ether and the like; alicyclic hydrocarbons such as cyclohexane and the like; aliphatic hydrocarbons such as normal hexane and the like; and mixture of aliphatic or aromatic hydrocarbons.

[0027]
[ENFORCEMENT FORMATS OF THIS INVENTION]
Preferred enforcement formats of the drying method of a coating film and device of the same relating to this invention are explained in details below with attached Figures.

[0028]
Figures 1 ~ 8 illustrate schematic drawing of each example of coating/drying line (10) to which this invention's drying method of a coating film and drying device are combined.

[0029]
As illustrated in the Figures, the coating/drying line (10) is mainly formed of a feed device (not illustrated in the Figures) that feeds a band-form flexible support body (12) that is coiled in a roll form, a means of coating (16) that coats coating solution on the band-form flexible support body (12), a drying device formed of a dryer (18) that condensates and collects solvent in the coating solution on a coating film formed by coating on the band-form flexible support body (12), a take up device (not illustrated in the Figures) that takes up a product manufactured through coating and drying, and multiple numbers of guide rollers (22), (22), ... that form a transport passage on which band-form flexible support body (12) travels.

[0030]
As the band-form flexible support body (12), resin films such as polyethylene, PET (polyethylene terephthalate), or TAC (triacetate) and the like, and papers or metal foils and the like may be used.

[0031]
Regarding means of coating (16), various types may be used. For example, slot-die coater (refer to Figure 1, Figure 5, and Figure 7), wire bar coater (refer to Figure 2, Figure 4, and Figure 8), roll coater, gravure coater (refer to Figure 6), slide hopper coating method (refer to Figure 3), or curtain coating method and the like may be used. _

[0032]
Furthermore, regarding means of coating (16), it may be structured in such manner so the coating plane [surface] faces top side against horizontal direction as illustrated in the Figure 1, Figure 3, Figure 5, and Figure 7, or it may be structured to face down side against horizontal direction as illustrated in the Figure 2, Figure 4, Figure 6, nd Figure 8. In addition, it may be also structured to show an incline against horizontal direction.

[0033]
As illustrated in the Figure 9, it is possible to install a dust proofing equipment (70) at the stage prior to means of coating (16), or to provide a pre-treatment and the like to the surface of band-form flexible support body (12). In the case of optical films and the like that seek high quality with hardly any dust, it is possible to obtain coated and dried film showing high quality through utilizing these means at the same time.

[0034]
Regarding dryer (18), it is composed of a condensation plate[s] (20) that is of a plate-form member and is arranged in an almost parallel manner to the band-form flexible support body (12) with prescribed distance, and side plate[s] and the like that is installed vertically downward from the front and back sides of the condensation plate (20). It is structured so the evaporated solvent would condensate and would be collected through such [configuration] when solvent within coating solution on the coating film evaporates.

[0035]
Regarding the material of the surface of condensation plate (20) that is designed to condensate solvent, it may be of metals, plastics, or wood material and the like and no particular limitations are placed; and when organic solvents are included in the coating solution, it is recommended to use such material that is durable against that organic solvent or to apply a coating on that surface.

[0036]
Regarding dryer (18), means to collect solvent that is condensed on the condensation plate (30) [note: original document describes condensation plate as (30) hereafter, and in some cases this is referred to as (20) translator's note] may be done in such way, for instance, through arrangement of groove on a condensation surface of the condensation plate (30) to collect solvent by utilizing a capillary force. Direction of the groove may be in the traveling direction of band-form flexible support body (12), or it may be in the orthogonal direction to that. When condensation plate (30) is tilted, it is all right to arrange a groove in the direction that is easy to collect the solvent.

[0037]
According to an example that is illustrated in the Figure 10, a wooden bucket (30a) is placed to collect condensed solvent at the bottom right edge of the condensation plate (30); and solvent is collected via wooden bucket (30a).

[0038]
Besides condensation plate (20) that is of a plate-form member, it is all right to use a structure showing the same function, for instance, components using porous plate, mesh, slatted drain-board, or roll and the like on the dryer (18). In addition, it is all right to jointly use a collection device as disclosed in the US5694701.

[0039]
Condensation plate[s] (20) that is of a plate-form member is installed on the dryer in an almost parallel manner to the band-form flexible support body (12) at prescribed distance; and regarding the structure that can vary the distance of condensation plate (20) and band-form flexible support body (12) in the traveling direction of the band-form flexible support body that is the structure capable of varying the distance of condensation plate (20) and band-form flexible support body (12) in the traveling direction of the band-form flexible support body [note: original documents repeats the same phrases as translated above, translators' note], as illustrated in the Figure 1 and Figure 2, it may be of such structure having installation of plural numbers of condensation plates (20), (20), (20) while allowing the distance of condensation plate[s] (20) and band-form flexible support body (12) to vary; or it may be of such structure in which condensation plate[s] (20) is made to tilt at prescribed angle against traveling direction of the band-form flexible support body to vary the distance of condensation plate[s] (20) and band-form flexible support body (12) in the direction of band-form flexible support body in a tapered manner (not illustrated in the Figures). In this case, the tilt angle of condensation plate (20) against traveling direction of the band-form flexible support body (12) is preferable when it is at the most 30°, or more preferably, at the most 20° against horizon.

[0040]
In addition, it may be of any of the following structures in order to display the same effect as explained above: a structure of which dryer (18) having a placement of plural number of condensation plates (20), (20), (20) of which these condensation plates (20), (20) are placed away from each other in the traveling direction of the band-form flexible support body (12); or a structure with a placement of diaphragms (28), (28), (28) between condensation (20), (20) [note: original document lacks term "plate" for (20), translator's note]; and a structure with a placement of condensation plates (20), (20), (20) on each plural number of box-shaped dryers (18), (18), (18) to closely attach box-shaped dryers (18), (18) mutually, or a structure having a placement of dryers (18), (18) that is apart from each other.

[0041]
There is no need that the dryer (18) and condensation plate (20) are necessarily in a straight line form as illustrated in the Figure 1 or Figure 2 and the like, and it is all right when the dryer (18) and condensation plate (20) are of arc shape as illustrated in the Figure 5 and Figure 7. In addition, it is all right to arrange a large drum having installation of said condensation plate.

[0042]
According to the example that is illustrated in the Figure 5 and Figure 7, it is designed to improve collection efficiency of the solvent by placing arc-shaped dryer (18) and condensation plate (20) close to the means of coating (16).

[0043]
It is preferable when dryer (18) is placed as close as possible to the means of coating (16) as it prevents from coating unevenness on the coating film caused by spontaneous convection immediately after coating of the coating solution. More specifically, it is recommended to place the inlet of the dryer (18) at the position that is within 5m from the means of coating (16); and it is more preferable when inlet of the dryer (18) is arranged at the position that is within 2 m from the means of coating (16); and it is most preferable when inlet of the dryer (18) is arranged at the position that is within 0.7m from the means of coating (16).

[0044]
Based on the same reason, it is preferable when traveling speed of the band-form flexible support body (12) is as such that said band-form flexible support body reaches dryer (18) within 30 seconds after coating by the means of coating (16), and it is more preferable when band-form flexible support body (12) reaches dryer (18) within 20 seconds after coating by the means of coating (16).

[0045]
Regarding coating weight of the coating solution and coating thickness, unevenness occurs naturally and easily when they are large because of easy occurrence of flow motion within a coating film; however, according to this invention, sufficient effect can be attained even when coating weight and coating film thickness happen to be large. It is possible to carry out efficient drying with no unevenness when thickness of coating film is 0.001 ~ 0.08 mm.

[0046]
When traveling speed of the band-form flexible support body (12) happens to be too large [fast], bordering layer nearby coating film becomes disturbed by accompanied wind [air] and shows ill affect on the coating film. And therefore, it is recommended to set the traveling speed of the band-form flexible support body (12) to 1 ~ 100 m/minute, or more preferably, 5 ~ 80 m/minute.

[0047]
It is recommended to heat band-form flexible body (12) and/or coating film, or to cool condensation plate (20), or use both measures in order to promote evaporation and condensation of the solvent in the coating solution. For instance, a cooling measure (not illustrated in the Figures) may be installed on the dryer, and means of heating (24), (24) are installed at the side opposite to the dryer in a manner of scissoring the band-form flexible support body (12) (make reference to Figure 4, Figure 6 and Figure 8).

[0048]
It is recommended to provide temperature management in order to control drying speed of the coating film in all cases. It is necessary to provide temperature management of the condensation plate (20) by installing cooling equipment on the condensation plate (20) for purpose of cooling when it is desired to cool. For this cooling, heat-exchanger type with water cooling using a coolant and the like, or air cooling type that uses wind [air], a method that uses electricity, for instance, a method that uses Peltier element and the like may be used.

[0049]
When it is desired to heat band-form flexible support body (12) or coating film, or both, a heater may be placed at the side opposite to the coating film for purpose of heating. In addition, it is also possible to heat through placement of a transport roll (heating roll) of which temperature may be raised. Besides these, it is all right to heat through use of infrared heater or means of heating that uses microwave and the like.

[0050]
When deciding the temperature of band-form flexible support body (12), coating film, condensation plate (20), caution must be paid so not to allow formation of dew drops of the evaporated solvent at the location other than the condensation plate (20), for instance, on the surface of transport roll and the like. And therefore, it is possible to avoid this type of formation of dewdrops by raising the temperature at the portion other than condensation plate (20) to higher than that of the condensation plate (20).

[0051]
Regarding the distance (gap) of a surface of coating film and a surface of condensation plate (20) of the dryer (18), it is necessary to adjust to appropriate distance by giving consideration over the prescribed drying speed of the coating film. While drying speed increases with shortened distance, it becomes easily affected by the precision on distance that is set. On the one hand, when distance is increased, it not only significantly reduces drying speed, but also spontaneous convection caused by heat occurs to trigger drying unevenness. It is recommended that the distance of a surface of coating film and surface of a condensation plate (20) of the dryer (18) is 0.1 ~ 200 mm, or more preferably, 0.5 ~ 100 mm.

[0052]
In addition, it is also possible to use a structure that varies setting temperature of means of heating (24), (24) in the traveling direction of the band-form flexible support body. For instance, according to the Figure 4 and Figure 6, setting temperature of means of heating (24) at upper flow side can be made lower than the setting temperature of means of heating (24) at lower flow side in the traveling direction of the band-form flexible support body (12). It is also possible to further control drying unevenness by setting in such manner.

[0053]
Similarly, it is also possible to use a structure that varies setting temperature of means of cooling on the dryer (18) in the traveling direction of the band-form flexible support body. According to the Figure 4 and Figure 6, setting temperature of means of cooling of the dryer (18) at upper flow side is varied from the setting temperature of means of cooling at lower flow side in the traveling direction of the band-form flexible support body. Furthermore, according to the Figure 4 and Figure 6, structure is a combination of installation of plural numbers of condensation plates (20), (20), (20) as well as design to change distance of condensation plate (20) and band-form flexible support body (12) in a stage-like manner.

[0054]
Besides these, it is possible to use various formats including a structure that is designed to vary setting temperature of means of heating (24), (24) in a stage-like manner, or a structure that is designed to vary setting temperature of means of cooling of the dryer (18) and the like.

[0055]
Furthermore, regarding feed device, guide roller (22), or take up device and the like that are used for the coating/drying line (10) that is combined with a drying device to which this invention's drying method of a coating film and device are applied are of commonly used members, and explanation on those are omitted.

[0056]
According to this invention's drying device of a coating film explained in detail above, it is possible to control unevenness that occurs on the coating film immediately after coating while drying said coating film uniformly with good efficiency. In addition, flexible design on the means of prescribing coating solution is possible without requiring a significant changes on the lay out of coating/drying processes by not being restricted by physical properties of coating solution or types of solvents and the like.

[0057]
That is to say, for instance, this invention's device and its same format may be implemented by simply adding installation of a dryer that condensates and collect solvent between a coating part of drying device and circulation drying device of the coating/drying device that includes existing circulation drying device As a result, it is possible to modify the device at less cost.

[0058]
In addition, according to this invention's drying device of a coating film, it displays effects on energy saving as well as cost reduction. In other words, of the evaporation gas that generates in the coating/drying line, solvent excluding water cannot be discharged to atmosphere as it is, and it is necessary to liquefy and collect this evaporation gas; and solvent collection equipment is required for that purpose. However, because solvent can be directly collected in a liquid state in the dryer that condensates and collects part of coating solution, it is possible to reduce load placed on the solvent gas collection equipment.

[0059]
When this invention's drying device of a coating film is jointly used with a circulation-drying device, it is possible to significantly cut down blast equipment for purpose of blowing wind [air]. And therefore, it is also possible to significantly cut down the cost of air conditioning equipment and the like, and offers very compact equipment.

[0060]
In addition, it was found that following unexpected effects to occur through use of this invention's drying device of a coating film with possible drying in very uniform level during initial period of drying: that is to say, because affect that disturbs coating film cannot be totally controlled by a conventional circulation drying device, flowing motion has been known to occur on a coating film. However, it was found that these flowing motions may be prevented through use of this invention's device to allow a very fine network structure of particles, and above all, it is possible to form these uniformly.

[0061]
Through this, it is not only possible to simply dry a coating film uniformly, but also structure of the coating film becomes finer that leads to, for instance, addition of newly added function in the case of optical films.

[0062]
In addition, for instance, it can be stated that this invention's drying device of a coating film is very well suited for drying of functional films including nano [level] particles and the like.

[0063]
According to this invention's drying device of a coating film, even when it is used for such coating solution in which solids such as polymer or particles and the like are dispersed, it provides the same effects. Or rather, the system that includes particles and the like is known for its large affect by occurrence of drying unevenness on the dispersion and distribution of the particles within a coating film. And therefore, it is recommended to use this system for said system.

[0064]
[EXAMPLES]
[EXAMPLE 1]
A dryer (18) that condensates and collects solvent in a coating solution was installed on a drying process of a coating film in the manufacturing line of optical compensation sheets that is illustrated in the Figure 9; and dryer structure suited from the standpoint of manufacturing of optical compensation sheets and conditions for condensation and collection of solvent were studied.

[0065]
As illustrated in the Figure 9, manufacturing line of optical compensation sheets consists of, for instance, processes described below.

1) Feed process (50) of a transparent film (12);
2) Process that forms (52) resin layer for purpose of forming a oriented film that is prepared by coating/drying a coating solution that includes resin for purpose of forming a oriented film on a surface of transparent film;
3) Lapping process (54) that forms oriented film on a transparent film on which surface, resin layer for purpose of forming an oriented film is formed through a lapping treatment that is applied on the surface of the resin layer;
4) Coating process (16) of discotic liquid crystal on an oriented film through a coating solution that includes discotic liquid crystal;
5) Drying process (18) that dries said coating film to evaporate solvent within said coating film;
6) Liquid crystal layer forming process (58) that forms liquid crystal layer of discotic nematic [disconematic] phase by heating said coating film up to the temperature that forms discotic nematic [disconematic] phase;
7) Process (60) to solidify said liquid crystal layer (in other words, either to solidify by quenching after forming a liquid crystal layer, or crosslinking through irradiation of light (or heating) when discotic liquid crystal compound that includes cross-linking functional radical is used);
8) Process (24) to take up transparent film on which said oriented film and liquid crystal layer are formed.

[0066]
Furthermore, according to the Figure 9, (62) shows a drying zone, (64) shows an inspection device, (66) shows a protective film, (68) shows a lamination machine, and (70) shows dust-proofing equipment respectively.

[0067]
Regarding manufacturing method of optical compensation sheets, it was conducted continuously from start of feed process of a long transparent film to the process that takes up thus given optical compensation sheets as illustrated in the Figure 3.A long chain alkyl modified poval (MP-203, made b Kuraray K.K.) solution was coated at 5 weight % on one side of a long film of triacetyl cellulose (Fujitac [transliteration] made by Fuji Photo Film K.K., thickness: 100 μm, width: 500 mm); and after it was dried for 4 minutes at 90°C, it was subjected to a lapping treatment to form resin layer for forming an oriented film with 2.0 μm film thickness. Transport speed of the film was 20 m/minute.

[0068]
Regarding above-explained triacetyl cellulose film, when refractive index of two directions that intersect on in-plane of the film are identified as nx, ny, and refractive index in thickness direction is identified as nz, and film thickness is identified as d, it was (nx-ny) x d=16nm, {(nx-ny)/2-nz} x d=75nm. In addition above-explained resin layer for forming of oriented film was conducted by using a coating/drying device.

[0069]
Then, resin layer surface of thus given film having a resin layer was subjected to a lapping treatment while this was transported continuously at 20 m/minute. Lapping treatment was conducted at 300-rpm rotation rate of lapping roller, and then, thus given oriented film was subjected to a dust removal.

[0070]
Then, while transporting thus given film with an oriented film continuously at 20 m/minute speed, it was coated with a 10 weight % methyl ethyl ketone solution (coating solution) that is a mixture prepared by adding 1 weight % of photo polymerization initiator (Irgacure 907 made by Japan Ciba Geigy K.K.) to a mixture of 4:1 weight ratio discotic compound TE-8 (3) and TE-8 (5) on the oriented film by using a wire bar coater at 20 m/minute coating speed and 5cc/m^2 coating weight; and then, it was passed through a drying and heating zone. Wind was blown into the drying zone, and heating zone was adjusted to 130°C. It was designed to enter drying zone 3 seconds after coating, and to enter heating zone 3 seconds after that. It was also designed to pass through heating zone in about 3 minutes..

[0071]
Then, the film on which said oriented film and liquid crystal layer were coated was irradiated with UV ray from an UV ray lamp on its liquid crystal surface layer while being transported continuously at 20 m/minute. That is to say, the film that passed through above-explained heating zone was irradiated with UV ray of 600 mW illuminance by using a UV ray irradiation device (UV ray lamp: 160W/cm output, light emission length 1.6m) for 4 seconds to crosslink liquid crystal layer.

[0072]
Tests were conducted on above-explained processes based on 6 types of conditions. Conditions and results are described below.

[0073]
(TEST 1)
Heater temperature was set at 85°C, and condensation plate temperature was set at 25°C. Dryer was arranged in such way so its inlet would be at the position that is 500 mm from the means of coating (16). Distance of a surface of coating film and surface of condensation plate (20) of the dryer (18) was set to be 3mm.

[0074]
Consequently, travel distance to attain a perfect drying of coating film required 6m. No problems on the qualities of coating film were noted.

[0075]
(TEST 2)
Heater temperature was set at 85°C, and condensation plate temperature was set at 25°C. Dryer was arranged in such way so its inlet would be at the position that is 500 mm from the means of coating (16). Distance of a surface of coating film and surface of condensation plate (20) of the dryer (18) was set to be 0.5 mm.

[0076]
Consequently, travel distance to dry coating film required 1m. Drying unevenness occurred on the coating film in width direction, and occurrence of orientation defects was also noted.

[0077]
(TEST 3)
Heater temperature was set at 85°C, and condensation plate temperature was set at 25°C. Dryer (18) was arranged in such way so its inlet would be at the position that is 500 mm from the means of coating (16). Condensation plate (20) was divided as 3 zones. In addition, said three condensation plates (20) were arranged with 5o angle of incline in such way so all of the down flow side in the traveling direction would be away from the coating film. Distance of surface of coating film and surface of condensation plates (20) of the dryer (18) was set to be 3mm, 1.5 mm, and 0.5 mm respectively toward down low side of the traveling direction.

[0078]
Consequently, travel distance to attain a perfect drying of coating film required 1.8 m. No problems on the qualities of coating film were noted. In other words, it was possible to attain shortening of process length in consistency with good qualities of the coating film based on these conditions.

[0079]
(TEST 4)
Heater temperature was set at 60°C, and condensation plate temperature was set at 25°C. Dryer (18) was arranged in such way so its inlet would be positioned at 500 mm from the means of coating (16). Distance of surface of coating film and surface of condensation plate (20) of the dryer (18) was set to be 1mm.

[0080]
Consequently, travel distance to attain a perfect drying of coating film required 5 m. No problems on the qualities of coating film were noted.

[0081]
(TEST 5)
Heater temperature was set at 60°C, and condensation plate temperature was set at 15°C. Dryer (18) was arranged in such way so its inlet would be at the position that is 500 mm from the means of coating (16). Distance of surface of coating film and surface of condensation plate (20) of the dryer (18) was set as 1 mm.

[0082]
Consequently, travel distance to attain a perfect drying of coating film required 2m. Drying unevenness on the coating film was noted in width direction. In addition, orientation defects also occurred.

[0083]
(TEST 6)
Heater temperature was set at 60°C, and dryer was arranged in such was so its inlet would be at the position that is 500 mm from the means of coating (16). Condensation plate (20) was divided as 3 zones. In addition, temperature of these 3 condensation plates was set at 25°C, 20°C, and 15°C respectively in the direction toward down flow side of the traveling direction. Distance of surface of coating film and surface of condensation plate (20) of the dryer (18) was set to be 1 mm.

[0084]
Consequently, travel distance to attain a perfect drying of coating film required 0.8 m. No problems on the qualities of coating film were noted. In other words, it was possible to attain shortening of process length in consistency with good qualities of the coating film based on these conditions.

[0085]
(EXAMPLE 2)
According to drying process after primer coating in the manufacturing line of photosensitive cellulose acetate film, comparison was made on the case in which this invention's dryer that condensates and collects solvent in the coating solution was installed and the case in which conventional circulation drying type dryer was installed.

[0086]
According to the manufacturing line that uses this invention's dryer illustrated in the Figure 10, cellulose acetate dope is flown onto a RYUEN [transliteration hereafter, this term could not be found in any of the dictionaries (at the least 9 dictionaries), it literally means flow and extend or draw, translator's note] die to a RYUEN drum surface, and the film thus formed is peeled off with a peel-off roller, and is dried with hot air while traveling between rolls of pre-drying process.

[0087]
Then, this was coated with a photographic photosensitive material primer, and was further dried with a dryer (18). At the point when residual solvent reached at the most about 10%, it was guided to a width regulating device (not illustrated in the Figures) to be drawn by 2 ~ 6 % in width direction, and after it was quenched in strained state, and then it was taken up.

[0088]
The condensation plate (20) of the dryer (18) was divided into two zones. In addition, two condensation plates (20) were arranged with such angle of incline so both of them would be apart from the coating film at down flow side of the traveling direction. Distance of a surface of coating film and surface of condensation plates (20) of the dryer (18) was set to be 0.8 mm at inlet side of the condensation plate (20) at upper flow side and 2 mm at outlet side in the direction toward down flow side of the traveling direction, and 0.8 mm at inlet side and 2mm at outlet side of the condensation plate (20) of down flow side.

[0089]
In addition, length of condensation plates (20) of upper flow side was set as 2 m and length of condensation plates of lower flow side as 4m. Setting temperature of condensation plates (20) was both at 15°C.

[0090]
Surface properties of thus manufactured product were good.

[0091]
According to the manufacturing line that uses conventional circulation drying type dryer that is illustrated in the Figure 11, device for primer coating drying process is of a conventional circulation drying type dryer. The other portions of the manufacturing line are of the same structure as illustrated in the Figure 10, and further explanation is omitted.

[0092]
Surface properties of thus manufactured product showed defects with occurrence of drying unevenness at the time or primer coating.

[0093]
[EXAMPLE 3]
Comparison was made on the example when means of drying that is a combination of dryer for condensation and collection (front stage side) and means of circulation drying (back state side) was installed on a drying process of manufacturing line of thermal development photosensitive material, and a case when only means of drying of conventional circulation drying type was installed.

[0094]
A coating solution for thermal development photosensitive material that is coated on a band-form flexible support body was adjusted in the manner explained below.

[0095]
1) ADJUSTMENT OF SILVER HALIDE PARTICLES
22g of phthalated gelatin and 30 mg of potassium bromide were dissolved in 700 m liter water, and after PH was adjusted to 5 at 35°C temperature, 159 m liter aqueous solution containing 18.6 g of silver nitrate and aqueous solution containing potassium bromide and potassium iodide at 92:8 mole ratio were added by taking 10 minutes through a control doublet jet method. Then, 476 m liter aqueous solution containing 55.4 g of silver nitrate and aqueous solution containing 10.5 μ mole/liter of secondary potassium iridium acid hexachloride and 1 mole/liter of potassium bromide were added by taking 30 minutes while maintaining 7.7 pAg using a control double jet method. Then, PH was lowered to desalt through a flocculation, and 0.11 g of phenoxy ethanol was added, and it was adjusted to PH5.9, pAg 8.2 to prepare silver iodobromide particles (cubic particles showing iodine core content 8 mole%, average 2 mole, average size 0.05 μm, fluctuation coefficient of projection area 8%, and (100) plane percentage 90%).

[0096]
Thus given silver halide particles were raised to 60°C temperature, and 85 μ mole of sodium thiosulfite, 11 μ mole of 2,3,4,5,6 pentafluoro phenyl diphenyl phosphine selenide, 15 μ mole of tellurium compound, 3.6 μ mole of chloroauric acid, and 280 μ mole of thiocyanate were added based on 1 mole of silver; and after it was ripened for 120 minutes, it was quenched to 30°C to give a silver halide emulsion.

[0097]

2) ADJUSTMENT OF ORGANIC ACID SILVER EMULSION

1.3 g of stearic acid, 0.5 g of arachidic acid, 8.5 g of behenic acid, and 300 m liter of distilled water were mixed for 40 minutes at 90°C, and while it was vigorously stirred, 31.1 m liter of 1N sodium hydroxide aqueous solution was added by taking 15 minutes, and then, it was raised to 30°C temperature. Then, 7 m liter of 1N phosphoric acid aqueous solution was added, and while it was vigorously stirred, 0.012 g of N-bromosuccinimide was added; and then, silver halide particles adjusted earlier were added to set the silver halide content to 2.5 m mole. Furthermore, 25 m liter of 1N silver nitrate aqueous solution was added by taking 25 minutes, and it was continued to be stirred for 90 minutes. Then, solids were filtered out with a suction filter, and solids were rinsed with water till electrical conductivity of thus filtered solution reached 30 μ S.cm. 37g of butyl acetate solution including 1.2 weight % of polyvinyl acetate was added to thus obtained solids; and it was stirred, and was left undisturbed after stirring was ceased to separate to oil layer [phase] and water layer [phase], and water layer was removed along with the salt included to give oil layer. Then, 20g of 2.5 weight % 2-butanone of polyvinyl butylal solution were added to this oil layer and were stirred. Furthermore, 0.1 m mole of pyridium perbromide and 0.18 m mole of calcium bromide dehydrate along with 0.7 g of methanol were added, and then, 40g of 2-butanone and 7.8 g of polyvinyl butylal were added; and it was dispersed in a homogenizer to give organic acid salt emulsion (needle-form particles showing 0.04 μm average short diameter [transliteration], 1 μ m average long diameter [transliteration], and 30% fluctuation coefficient [note: above transliteration of short and long diameter may be also translated as minor and major, translator's note]).

[0098]

3) ADJUSTMENT OF COATING SOLUTION OF EMULSION LAYER

Each chemical shown below was added to organic acid silver salt given in the manner explained above in a manner so it would be the amount as described below per 1 mole of silver. Addition of the followings were made at 25°C while stirring, and was left undisturbed for 3 hours: 10 mg of sodium phenyl thiosulfonate, 68 mg of coloring matter 1, 30 mg of coloring matter 2, 2 g of 2-mercapto-5-methyl benzoimidazole, 21.5 g of 4-chlorobenzophenone-2-carboxylic acid, 580 g of 2-betanone, and 220 g of dimethyl formamide. Then, followings were added while stirring: 8 g of 5-tribromomethyl sulfonyl-2-methyl thiadiazole, 6g of 2-tribromomethyl sulfonyl benzothiazole, 5g of 4,6-ditrichloromethyl-2-phenyltriazine, 2g of disulfide compound, 160 g of 1,1-bis (2-hydroxy-3, 5-dimethyl phenyl)-3,5,5 trimethyl hexane, 5 g of tetrachlorophthalate, 1.1 g of fluorine group surfactant, 590 g of 2-butanone, and 10 g of methyl isobutylketone.

[0099]
The coating solution for emulsion layer that was adjusted as explained above was coated on a polyethylene terephthalate support body with 175 μm (band-form flexible support body) that was tinted blue with a blue dye in such manner to provide 2.3g/cm^2 silver. Then, after said coating, in the case of example, it was dried with a dryer (front stage side) that condensates and collects and means of circulation drying (back stage side), and was irradiated with UV ray to give a thermal development photosensitive material. On the one hand, in the case of comparative example, coating film was dried only with a circulation drying type dryer, and it was irradiated with UV ray to give a thermal development photosensitive material.

[0100]
Surface properties of the product manufactured by the method described in the example were good. On the one hand, surface properties of the product manufactured by the method described in the comparative example showed defects by being affected with uneven wind.

[0101]
(EXAMPLE 4)
Comparison was made on a case of example in which means of drying that is a combination of condensation and collection dryer (front stage side) and means of circulation drying (back stage side) that was installed on the drying process of manufacturing line of hard coating film, and a case of comparative example in which only the means of drying by a conventional circulation drying type was installed.

[0102]
Coating solution for hard coating that is coated on a band-form flexible support body was adjusted in the manner explained below.

1) ADJUSTMENT OF INORGANIC PARTICLE DISPERSEDSOLUTION (M-1)
Following reagents were compounded at the compounding rate shown below in a ceramic-coated container to adjust a solution mixture:

[0103]
Cyclohexane – 337 g
Methacrylate containing phosphoric acid radicals (PM-2: made by Nihon Kayaku K.K.) – 31g
Alumina (AKP-G015: made by Sumitomo Kagaku Kogyo K.K., particle size 15 nm) – 92g

A solution mixture given was finely dispersed for 10 hours in a sand mill (1/4 G sand mill) at 1600 rpm. 1400 g of zirconia beads with 1 mm Φ were used as medium. After dispersion, zirconia beads were separated to give a dispersed solution of surface modified inorganic particles (M-1).

[0104]
2) ADJUSTMENT OF COATING SOLUTION FOR ACTIVE ENERGY BEAN CURABLE LAYER

To 116 g of 43 weight % cyclohexanone dispersed solution (M-1) of surface treated alumina fine particles, 97 g of methanol and 163 g of isopropanol were added; and in addition, 163 g of methyl isobutyl ketone was added. To this mixture solution, 200 g of mixture (DPHA made by Nihon Kayaku K.K.) of dipentaerithritol penta acrylate and dipentaerithritol hexa acrylate were added and dissolved. Furthermore, 7.5 g of photo polymerization initiator (Irgacure 184 made by Ciba Geigy K.K.) was added and dissolved. After stirring this mixture for 30 minutes, it was filtered with a 1 μm pore diameter filter made of polypropylene to adjust a coating solution for active energy beam curable layer.

[0105]
3) [note: there is no title to this 30. translator's note]

After glow discharge treating a band-form flexible support body (base film), coating solution for active energy beam curable layer that includes alumina was coated with means of wire bar coating to give 8 μm dry film thickness. Then, after said coating, in the case of example, it was dried with a condensation and collection dryer (front stage side) and means of circulation drying (back stage side), and it was UV ray irradiated to give a cured layer. On the one hand, in the case of comparative example, after coating film was dried only with a circulation drying type dryer, it was UV ray irradiated to give a cured layer.

[0106]
Then, comparison was made on a case of example in which means of drying that is of a combination of condensation and collection dryer (front stage side) and means of circulation drying (back stage side) that was installed on the drying process of manufacturing line of thick hard coating film, and a case of comparative example in which only the means of drying with conventional circulation drying type was installed.

[0107]
Coating solution for thick hard coating film that is coated on a band-form flexible support body was adjusted in the manner explained below.

[0108]

1) ADJUSTMENT OF COMPOUND THAT CONTAINS RING-OPENING POLYMERIZABLE RADICALS (K-1)

Polymerization initiator added solution was adjusted by first stirring 275 m liter of methyl ethyl ketone (MEK) under nitrogen gas flow at 60°C for 1 hour, and adding total amount prepared by dissolving 0.5 g of polymerization initiator (V-65 made by Wako Junyaku K.K.) in 8.3 m liter MEK. Then, 50g of glycidyl methacrylate was dropped by taking 2 hours, and after completion of said dropping, polymerization initiator added solution that was adjusted beforehand was added to react for 2 hours. Then, reaction temperature was set at 80°C and was reacted for 2 hours, and after completion of said reaction, it was cooled down to room temperature. Thus given reaction solution was dropped in 10 liter of hexane by taking 1 hour; and precipitates were dried at 35°C for 8 hours under reduced pressure to give compound that contains ring-opening polymerizable radicals (K-1).

[0109]

2) ADJUSTMENT OF CURABLE COMPOSITION

After dissolving 75 parts of trimethylol propane triacrylate (ethylenic unsaturated radical containing compound), 25 parts of ring-opening polymerizable radical containing compound (K-1) adjusted beforehand, radical polymerization initiator (Irgacure 184 made by Ciba Geigy K.K.), and cation polymerization initiator (UVI-6990 made by Union Carbide Japan K.K.) in 40 parts of mixture solution of methyl isobutyl ketone/methyl ethyl ketone (1/5), it was stirred for 30 minutes to give a curable composition. Furthermore, regarding polymerization initiator, addition of 2.9 weight % of each radical polymerization initiator and cation polymerization initiator based on total amount of ethylenic unsaturated radical containing compound and ring-opening polymerizable radical containing compound was made.

[0110]

3) [note: there is no title to this 3). Translator's note]

Regarding a transparent band-form flexible support body (transparent base film), polyethylene terephthalate film with 188 μm thickness was used; and after this was subjected to a glow discharge treatment, curable composition that was adjusted as explained above was coated through a coating method of extrusion type. Then, after said coating, in a case of example, a thick hard coating film was obtained by first drying through a condensation and collection dryer (front stage side) and means of circulation drying (back stage side), it was UV ray irradiated, and was further heated for 10 minutes at 120°C. On the one hand, in the case of comparative example, after coating film was dried only with a circulation drying type dryer, it was UV ray irradiated and was further heated for 10 minutes at 120°C to give a thick hard coating film. Furthermore, drying was conducted based on such conditions as for 2 minutes at 120°C and UV ray irradiation of 750 mj/cm^2.

[0111]
Surface properties of the product manufactured by the method described in the examples were good. On the one hand, surface properties of the product manufactured by the method described in the comparative example were defective with occurrence of uneven thickness that can be possibly blamed on the affect of uneven wind [air].

[0112]
[EFFECTS OF THIS INVENTION]
According to this invention's drying method of a coating film and device of the same, it is possible to control drying unevenness that occurs immediately after coating on a long and wide coating film surface formed by coating various liquid-form compositions on a continuously traveling band-form flexible support body, and in addition, it is possible to dry said coating film uniformly with good level efficiency.

[0113]
In addition, because it does not need to alter the lay out of coating and drying process as well as not being greatly restricted by physical properties or types of solvent in the coating solution, flexible design on means of coating solution prescription is possible. In addition, it displays effects such as energy saving as well as reduced cost.

[0114]
Furthermore, it is possible to prevent from fluid motion within a coating film to allow formation of very fine and above all uniform network structure of polymer as well as particles in the coating film that is formed during drying.

[BRIEF DESCRIPTION OF THE FIGURES]
[FIGURE 1]
It illustrates schematic drawing of one example of coating and drying line (10) combined with a drying device to which this invention's drying method of a coating film and device of the same are implemented.

[FIGURE 2]
It illustrates a schematic drawing of other example of coating and drying line (10) combined with a drying device to which this invention's drying method of a coating film and device of the same are implemented.

[FIGURE 3]
It illustrates a schematic drawing of one other example of coating and drying line (10) combined with a drying device to which this invention's drying method of a coating film and device of the same are implemented.

[FIGURE 4]
It illustrates a schematic drawing of one another example of coating and drying line (10) combined with a drying device to which this invention's drying method of a coating film and device of the same are implemented.

[FIGURE 5]
It illustrates a schematic drawing of other example of coating and drying line (10) combined with a drying device to which this invention's drying method of a coating film and device of the same are implemented.

[FIGURE 6]
It illustrates a schematic drawing of one other example of coating and drying line (10) combined with a drying device to which this invention's drying method of a coating film and device of the same are implemented.

[FIGURE 7]
It illustrates a schematic drawing of one another example of coating and drying line (10) combined with a drying device to which this invention's drying method of a coating film and device of the same are implemented.

[FIGURE 8]
It illustrates a schematic drawing of other example of coating and drying line (10) combined with a drying device to which this invention's drying method of a coating film and device of the same are implemented.

[FIGURE 9]
It illustrates a schematic drawing that shows an example that uses drying device of coating film of this invention for a manufacturing line of optical compensation sheets.

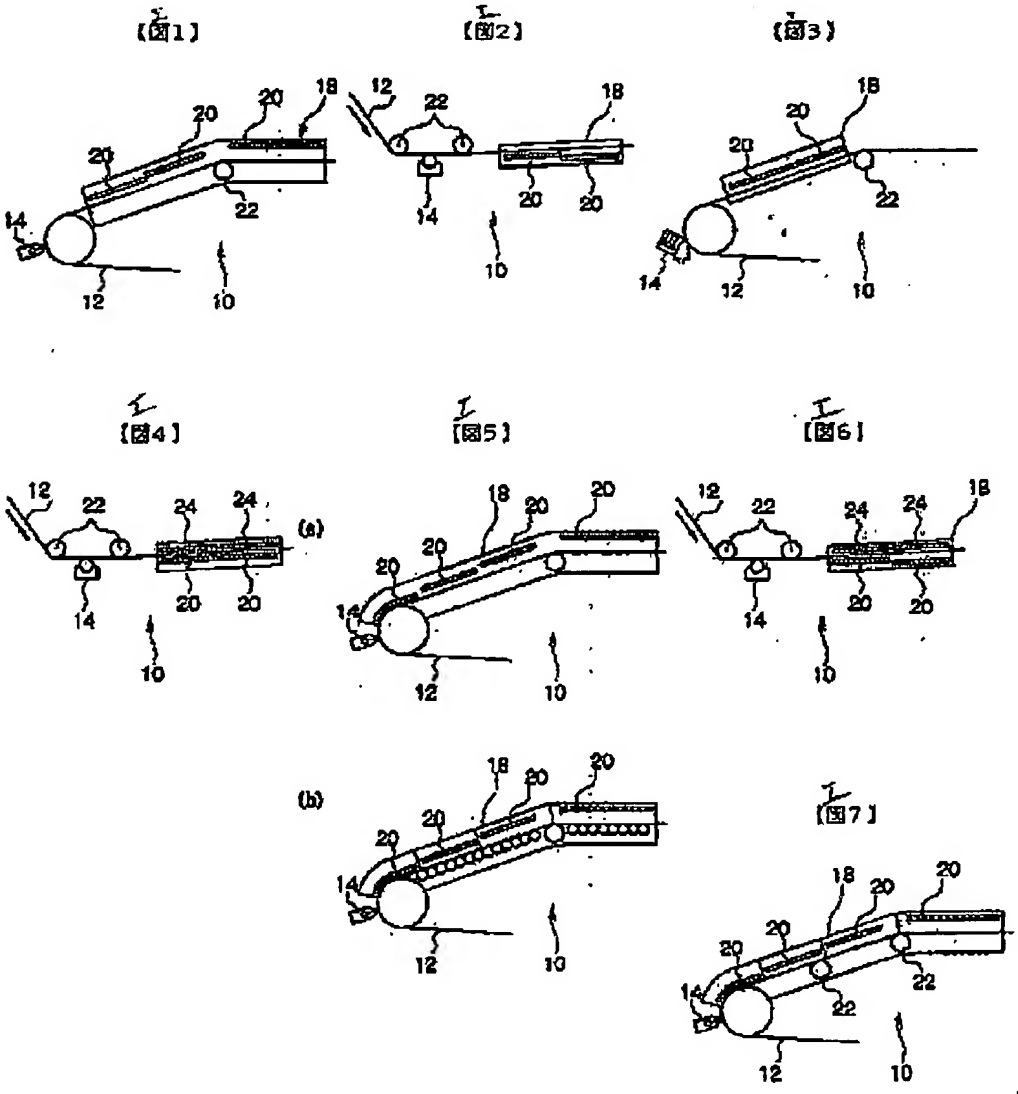
[FIGURE 10]
It illustrates a schematic drawing that shows an example that uses drying device of coating film of this invention for a manufacturing line of photosensitive cellulose acetate films.

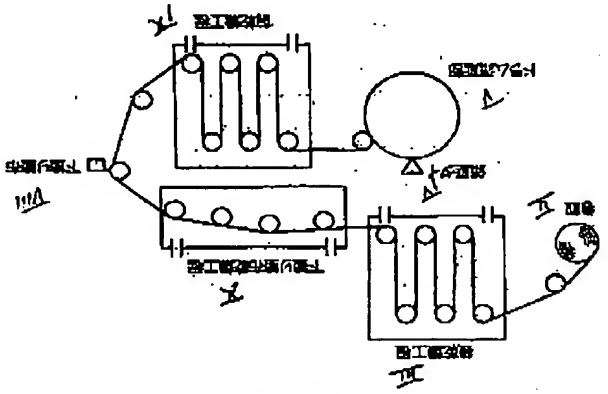
[FIGURE 11]
It illustrates a schematic drawing that shows an example that uses circulation drying type dryer of conventional example for a manufacturing line of photosensitive cellulose acetate films.

[DESCRIPTION OF CODES]
10: coating and drying line, 12: band-form flexible support body, 16: means of coating, 18: dryer, 20: condensation plate, 22: guide roller, 24: means of heating, 28: diaphragm.

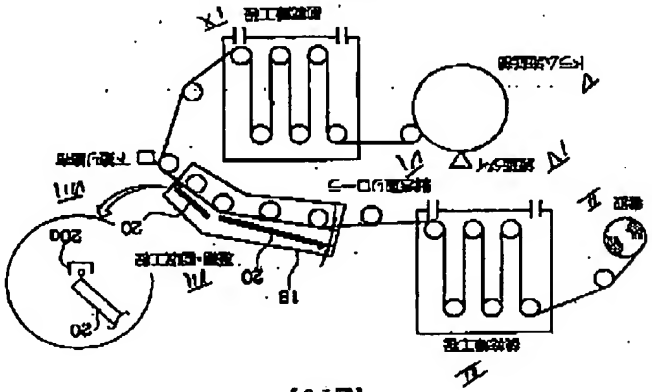
Translation requested by: Brian Szymanski, OIPC
Translation by: Mie N. Arntson, 512-331-7167

Figures 1 through 11
I: Figure, II: take up, III: post-drying process, IV: RYUEN [transliteration] die, V: RYUEN part of a drum, VI: peel off roller, VII: condensation and collection process, VIII: primer coating, IX: pre-drying process, X: primer coating drying process,

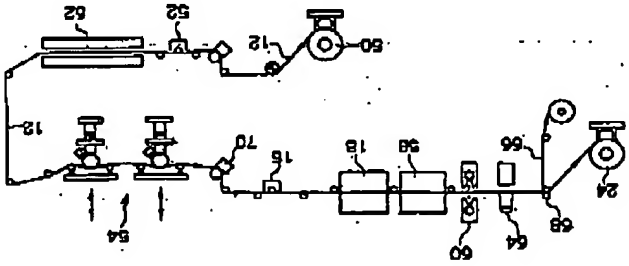




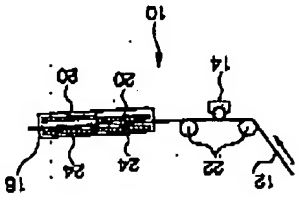
【図11】



【図10】



【図9】



【図8】